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ABSTRACT

Biology I students (n=166) in a high school in southern Mississippi completed the Learning Styles Inventory, a 45-item instrument designed to measure preference for channel of learning (visual, auditory, or kinesthetic), sociological environment (individually or in groups), and mode of expression (oral or written). A three-way analysis of variance was used to examine learning style preferences based on sex, race, and level of course (regular or honors). Students in the honors classes were significantly different from students in regular classes in preference for learning through visual language and for reporting their knowledge through oral expression. African-American females were significantly lower in preference for kinesthetic or active learning than were the other groups. There was a three-way interaction among sex, race, and level for written expression, with African American females and white males in honors classes showing higher preference for written expression than those in regular classes. There was no difference in preference for written expression between African American males and white females in honors and those in regular classes. A cluster analysis was used to describe three groups whose learning styles preferences can be addressed in the biology classroom: (1) the "scholars," who prefer learning through visual language, working individually, and showing what they have learned through written expression (21%); (2) the "active learners," who prefer learning through listening, engaging in active learning, and reporting what they have learned through oral expression (44%); and (3) "social butterflies," who show no preference other than working in groups (35%). (Contains 9 tables and 12 references.) (Author/SLD)

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Scholars, Active Learners, and Social Butterflies:

Preferred Learning Styles of High School Biology I Students

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Abstract

One-hundred sixty-six Biology I students in a high school in southern Mississippi completed the Learning Styles Inventory, a 45-item instrument designed to measure preference for channel of learning (visual, auditory, or kinesthetic), sociological environment (individually or in groups), and mode of expression (oral or written). A three-way ANOVA was used to examine learning style preferences based on sex, race, and level of course (regular or honors). Students in the honors classes were significantly different from students in regular classes in preference for learning through visual language and for reporting their knowledge through oral expression. African-American females were significantly lower in preference for kinesthetic or active learning than were the other groups. There was a three-way interaction among sex, race, and level for written expression, with African-American females and white males in honors classes showing higher preference for written expression than those in regular classes. There was no difference in preference for written expression between African-American males and white females in honors and those in regular classes. A cluster analysis was used to describe three groups whose learning styles preferences can be addressed in the biology classroom: the "scholars," who prefer learning through visual language, working individually, and showing what they have learned through written expression (21%); the "active learners," who prefer learning through listening, engaging in active learning, and reporting what they have learned through oral expression (44%); and the "social butterflies," who show no preference other than working in groups (35%). The learning, working, and reporting preferences of these students can be addressed with a number of instructional techniques.

Scholars, Active Learners, and Social Butterflies:
Preferred Learning Styles of Biology I Students

Since the 1970s, educational researchers have attempted to explain and categorize the different ways in which people learn and retain information and concepts. "Cognitive styles" or "learning styles" have been defined as "self-consistent, enduring individual differences in cognitive organization and functioning" (Ausubel, Novak, & Hanesian, 1978, p. 203), "cognitive, affective, and physiological traits that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment" (Keefe, 1982, p. 44), and "distinctive behaviors which serve as indicators of how a person learns from and adapts to his environment" (Gregorc, 1979, p. 234).

Theoretical frameworks have included categorization of learning styles as field-dependent/global or field-independent/analytic (Ramirez & Castenada, 1974; Witkin, 1976) and concrete-abstract and random-sequential (Gregorc, 1979). Dunn and Dunn (1979) describe four groups of elements in which learners have distinct preferences: environmental (sound, light, temperature, and design), emotional (motivation, persistence, responsibility, and a need for structure), sociological (working alone, with others, or with an adult), and physical (perceptual strengths, including visual, auditory, tactile, and kinesthetic; intake, time of day, and need for mobility).

Some theories are intended to promote personal awareness; others, to use in designing curriculum and instruction for groups of learners; still others, to provide learning environments tailored to individuals (Brandt, 1990). Some search for evidence of modality "strength," the channel or channels the individual actually uses in learning; others measure "preference," the

elements in the learning environment the individual prefers to others.

In addition to research that describes learning styles, their discovery, and their uses, much has been done to link different styles to such variables as academic achievement, race, and sex. Barbe and Milone (1981) found that children with preference for auditory learning usually perform poorly on standardized tests. Dunn (1993) discovered that underachievers tend to be kinesthetic and that average children learn by reading (visual) rather than by listening (auditory).

According to Guild (cited in Brandt, 1990, p. 11), "cultural values do impact a learner's style." Jalali (1989) reported that African-American children preferred working with peers to working alone. Barbe and Milone (1981), however, found modality strength--use of visual, auditory, or kinesthetic channels of learning--to be independent of race.

The research on sex differences is also mixed. Both Restak (1979) and Dunn (1993) found males to be more kinesthetic than females; Restak found males to be kinesthetic longer than were females. Both also found females to be more auditory than males. Barbe and Milone (1981) found no clear difference in modality strengths of males and females.

The intention of this study was to characterize the learning style preferences of students in a small Southern high school on three dimensions: channel of learning (visual, auditory, or kinesthetic), sociological environment (individual or group), and mode of expression (oral or written). Hypotheses were as follows:

H1: There is no difference in learning styles of students based on academic achievement, as measured by placement in an honors or in a regular class.

H2: There is no difference in learning styles of students based on race.

H3: There is no difference in learning styles of students based on sex.

Researchers differ, too, on how knowledge of learning styles can best be used in the classroom. Some advocate matching teachers and students with similar preferences. Others advocate teaching to each individual's strength, using secondary preferences as alternative approaches. Still others prefer strengthening weaker modalities by using them in instruction. The purpose of this study was to provide teachers with information about the learning styles of students in their classrooms and to provide them with techniques for addressing learning styles differences.

Method

Participants

The participants in this study were 166 high school students enrolled in Biology I honors and "regular" classes at a high school located in a small town in southern Mississippi. Seventy-four percent of the students were freshmen, 12% were sophomores, 12% were juniors, and 4% were seniors. A breakdown by level, race, and sex is given in Table 1.

Table 1

Participants by Level, Race, and Sex

	Honors Classes		"Regular" Classes	
	White	African-American	White	African-American
Male	21 (12.7%)	7 (4.2%)	14 (8.4%)	46 (27.7%)
Female	24 (14.5%)	6 (3.6%)	9 (5.4%)	39 (23.5%)

Design and Procedure

Students were administered the Learning Styles Inventory during regularly scheduled

class periods of Biology I. The administrator read each item aloud, requesting students to mark "Most Like Me," "Like Me," Not Like Me," and "Least Like Me" in response to each item. Students were permitted to read silently and work at their own pace if they chose to do so. Inventories were self-scored. Students put their names on their answer sheets so that the instrument could be included in their individual career portfolios. Each of the two teachers participating in the study then marked each student's answer sheet as to sex and race. Level for each student was determined by class period and teacher.

The Learning Styles Inventory, a 45-item instrument developed by the Center for Innovative Teaching Experiences, is intended to elicit style preferences in three areas: channel of learning (visual, auditory, or kinesthetic) for both language and numbers, sociological environment (group or individual learner), and mode of expression (oral or written). A explanation of learning styles as measured by the Learning Styles Inventory is given in Table 2. A copy of the instrument and directions for scoring are included in the Appendix.

The reliability of the instrument was tested in two phases on 2,229 7th, 8th, and 9th graders in the Wichita, Kansas, school system in the mid-1970s. Split-half reliability coefficients for each item varied from .40 to .80, with more than 70% in the .60-.80 range. The authors of the instrument (Babich & Randol, n.d.) suggested that validity studies be considered in future research. The school district in which the present studies were conducted purchased the rights to use the Learning Styles Inventory in written and interactive-computer form from Piney Mountain Press, Inc.

Table 2

Definition of Learning Styles

Style	Definition
Visual Language	The way a student sees words; processing written language
Auditory Language	The way a student hears words; processing spoken words
Visual Numerical	The way a student sees numbers; processing visual numerical values
Auditory Numerical	The way a student hears numbers; processing spoken numerical values
Kinesthetic	The way a student learns by doing or involvement; emphasizing the experiencing or manipulative learning styles; almost always accompanied by either auditory or visual stimuli or a combination of both
Group Learner	A student who likes to work with at least one other person when there is important work to be done
Individual Learner	A student who works and thinks best alone; usually a self-starter; frequently finds working with other students distracting
Oral Expressive	A student who prefers to say what he knows; answers or explanations usually given orally
Written Expressive	A student who prefers to write down answers or explanations

Note. From Learning Styles Inventory Reliability Report by A. M. Babich and P. Randol (n.d.).

Data Analysis

The Learning Styles Inventory contains five statements for each of the nine learning style preferences. Scores for each item range from 1 ("Least Like Me") to 4 ("Most Like Me"). In the final scoring, responses for each style preference were added and then multiplied by two, resulting in scores for each style from a low of 10 to a high of 40. Scores above 32 are considered a "major learning style." Those from 20 through 32 are considered a "minor learning style." Means and standard deviations for scores for each learning style preference are given in Table 3. All means were normally distributed.

Table 3

Means and Standard Deviations of Learning Style Preference Scores

Learning Style Preference	M	SD
Visual Language	25.84	7.92
Auditory Language	29.63	7.05
Visual Numerical	30.95	5.82
Auditory Numerical	30.66	5.59
Kinesthetic	28.96	6.16
Group Learner	29.52	7.06
Individual Learner	28.73	8.51
Oral Expressive	29.31	7.08
Written Expressive	26.84	6.22

A frequency distribution for student preference for visual learning vs. auditory learning were determined by adding the scores for visual language and visual numerical and subtracting from them the combined scores for auditory language and auditory numerical. Frequency distributions of visual language vs. auditory language, visual numerical vs. auditory numerical, group learner vs. individual learner, and oral expressive vs. written expressive are illustrated in Table 4.

Table 4

Frequency Distributions for Learning Style Preferences

Learning Style Preference	Frequency	Percentage
Visual (Combined language and numerical)	36	21.7
Auditory (Combined language and numerical)	124	74.7
No Preference	6	3.6
Visual Language	42	25.3
Auditory Language	110	66.3
No Preference	14	8.4
Visual Numerical	75	45.2
Auditory Numerical	73	44.0
No Preference	18	10.0
Group Learner	83	50.0
Individual Learner	72	43.4
No Preference	11	6.7

Table 4, continued

Frequency Distributions for Learning Style Preferences

Preferred Learning Style	Frequency	Percentage
Oral Expressive	92	55.4
Written Expressive	59	35.5
No Preference	15	9.0

A three-way analysis of variance (ANOVA) was used to determine significant differences among the groups on the nine learning style preferences. Significant differences were found for four of the nine learning styles preferences, as shown in Tables 5-8.

Table 5 shows that students in the honors classes had a significantly stronger preference for visual language, i.e., reading, than did students in the "regular" classes. The mean response for honors students was 27.86; for regular students, 24.76. This difference was significant at the .05 level.

Table 5

Analysis of Variance for Visual Language

Source	df	F
Sex	1	0.571
Race	1	0.010
Level	1	4.037*
Sex x Race	1	0.295
Sex x Level	1	0.189
Race x Level	1	0.097
Sex x Race x Level	1	0.824
Residual	158	

*$p < .05$.

Sex-race and sex-level interactions were discovered on the variable of kinesthetic learning, as shown in Table 6. African-American females showed a significantly lower preference for kinesthetic, i.e., active learning, than did the other three sex-race groups. This difference was significant at the .001 level. Means for the groups were as follows:

African-American females	26.32
African-American males	30.08
White females	30.55
White males	29.09

Table 6

Analysis of Variance for Kinesthetic Learning

Source	df	F
Sex	1	3.202
Race	1	0.735
Level	1	0.740
Sex x Race	1	12.756***
Sex x Level	1	4.661*
Race x Level	1	3.464
Sex x Race x Level	1	0.001
Residual	157	

*p < .05. **p < .01. ***p < .001.

There were also significant differences along sex-level divisions at the .05 level. Means were as follows:

Regular females	27.62
Honors females	28.93
Regular males	29.13
Honors males	30.86

Although preference for active learning was higher in males than in females, this difference was not significant at the .05 level.

Students in the honors classes showed a stronger preference for oral expression than did students in the regular classes, as shown in Table 7. Mean for the honors classes was 31.07; for the regular classes, 28.36. This difference was significant at the .05 level.

Table 7

Analysis of Variance for Oral Expression

Source	df	F
Sex	1	0.040
Race	1	0.073
Level	1	4.396*
Sex x Race	1	0.127
Sex x Level	1	0.006
Race x Level	1	0.259
Sex x Race x Level	1	0.049
Residual	157	

*$p < .05$.

A three-way interaction among sex, race, and level was found for written expression, as shown in Table 8.

Table 8

Analysis of Variance for Written Expression

Source	df	F
Sex	1	0.028
Race	1	2.029
Level	1	4.566*
Sex x Race	1	0.006
Sex x Level	1	0.530
Race x Level	1	0.333
Sex x Race x Level	1	8.414**
Residual	158	

*p < .05. **p < .01. ***p . < .001.

African-American males and white females in honors and regular classes exhibited little difference in preference for written expression. On the other hand, African-American females and white males in the honor classes showed a significantly higher preference for written expression than did their counterparts in the regular classes. Means are as follows:

	Honors Classes	Regular Classes
African-American females	31.33	26.26
African-American males	26.00	27.13
White females	26.33	27.56
White males	29.29	22.71

A hierarchical cluster analysis was performed to aid teachers in targeting groups of students for style-based instruction. Ward's method was used to minimize within-cluster variance; hierarchical structure analysis was aided by construction of a dendogram, or tree graph. Three clusters emerged:

Cluster	n	Percent	Preferences
"The Scholars"	35	21.1	Visual Language
			Individual Learner
			Written Expression
"Active Learners"	72	43.4	Auditory Language
			Kinesthetic
			Oral Expression
"Social Butterflies"	58	35.0	Group Learner

Cluster group means and significance levels are shown in Table 9.

Table 9

Group Means and Significance Levels for Hierarchical Clusters

Variable	Cluster			F
	1	2	3	
Visual Language	32.34	25.61	22.31	22.031***
Auditory Language	23.37	31.76	30.59	22.391***
Visual Numerical	30.06	32.86	29.31	7.193**
Auditory Numerical	27.46	32.89	29.83	13.95***
Kinesthetic	25.31	31.50	28.00	15.228***
Group Learner	24.51	27.89	34.72	38.839***
Individual Learner	33.54	33.86	19.45	149.641***
Oral Expressive	24.46	32.14	28.72	16.9167***
Written Expressive	30.91	27.01	24.07	15.665***

**$p < .01$. ***$p < .001$.

Analysis

The most important conclusion to be drawn from this study is that there are indeed dramatic differences in learning style preferences. Traditional teaching techniques emphasizing visual language (i.e., reading), individual work, and written expression address the needs of some students, but certainly do not address the needs of *all* students. Although many of the students in this group prefer learning in traditional modes, many also prefer learning through listening, working in groups, and expressing themselves orally.

In this study, higher achievers--those in honors classes--showed stronger preference for learning through visual language than did lower achievers. This finding is consistent with that of Barbe and Milone (1981), who found that auditory children performed less well on standardized tests. Since much teaching and testing relies on visual language, it is not surprising that those who prefer listening to reading do less well in teaching and testing situations that require them to read. Higher achievers in this group also exhibited a stronger preference for oral expression, perhaps due to confidence in their ability to use the language to demonstrate their knowledge. Unlike the group researched by Dunn (1993), some low achievers in this group--the African-American females--were *less* kinesthetic than the higher achievers. Perhaps this difference has something to do with the age of the participants. In Dunn's study, the highly kinesthetic behavior of low achieving elementary students may have interfered with their being able to focus on academic tasks. For the high school girls in this study, perhaps their preference for inactivity keeps them from generating the energy needed to achieve high academic performance.

As Barbe and Milone found modality strength to be independent of race, this study found modality preference to be largely independent of race. Although African-American students

showed a stronger preference for learning through auditory language (mean=30.52) than did the white students (mean=29.30), the difference was not significant at the .05 level ($p = .091$). Like the students in Jalali's study (1989), African-American students in this study preferred to work in groups--but so did their white colleagues. Means were nearly identical (29.53 and 25.50) and were thus not significantly different at the .05 level. African-American females at both levels were shown to have less preference for kinesthetic learning; African-American females in honors classes showed a much stronger preference for written expression than did their counterparts in regular classes.

Like the students in Restak's (1979) and Dunn's (1993) studies, males in this study showed a stronger preference for kinesthetic learning (mean=29.68) than did females (mean=28.13), but the difference was not significant ($p = .075$). As previously discussed, African-American females showed the lowest preference for kinesthetic activity. As Restak found, females were more auditory (mean=30.01) compared to males (29.30), but again the difference was not significant ($p = .483$).

Recommendations

The cluster analysis resulting in three groups--"scholars," "active learners," and "social butterflies"--may aid teachers in visualizing the students they are attempting to reach without being overwhelmed with the task of addressing each student's unique preferences in learning style. It is only important that teachers use a variety of techniques aimed at providing every student with learning in preferred ways--at least some of the time.

For the "scholars," instruction should include the following:

Visual Language	Provide a variety of written material on several levels of difficulty. Provide important information on the board or in handouts. Require note taking.
Individual Learner	Allow students to study in the library or in a corner of the classroom. Don't force group work on an unwilling learner.
Written Expressive	Encourage students to write reports, keep diaries and journals, and communicate with you and each other in written form. Provide opportunities for publication.

For the "active learners," include choices involving the following:

Auditory Language	Provide audio tapes, oral practice, and class discussion. Use small groups and student-teacher interaction to increase the amount of verbal information available in the classroom. Encourage students to teach each other.
Kinesthetic Learner	Provide opportunities for active learning, including use of manipulatives, role-playing, and artistic and musical expression.
Oral Expressive	Give students opportunities to present their work in oral form through speeches, presentations, plays, or demonstrations.

Make sure that "social butterflies" have the opportunity to work with peers, as well as expand their skills in other areas:

Group Learner	Provide opportunities for students to work together in groups. Encourage pairing for classwork and homework.

No group showed a strong preference for visual numerical over auditory numerical, but both styles should be included in all instruction involving the use of numbers:

Visual Numerical	Provide worksheets, workbooks, and textbooks. Provide important information in written form.
Auditory Numerical	Read problems aloud. Allow students to "talk through" solutions to problems. Provide spoken explanation for all important concepts.

According to Dunn (1979), we can most effectively respond to differences in student learning styles not by matching students with teachers of similar styles but by expanding the modes of operation each teacher uses. By including a variety of techniques such as those listed above, teachers can ensure that they reach *all* students--at least some of the time.

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